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Radiochemical and Chemical Constituents in Water from Selected Wells and Springs from the Southern Boundary of the Idaho National Laboratory to the Hagerman Area, Idaho, 2003

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Cover: Well discharge to a stilling pond on Snake River Plain

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By Gordon W. Rattray and Amy J. Wehnke, U.S. Geological Survey, L. Flint Hall, State of Idaho, Department of Environmental Quality, Division of INL Oversight and Radiation Control, and Linford J. Campbell, Idaho Department of Water Resources

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Conversion Factors and Abbreviated Water-Quality Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
gallon (gal)	3.785	liter (L)
gallon (gal)	0.003785	cubic meter (m^3)
	Radioactivity	
picocurie per liter (pCi/L)	0.037	becquerel per liter (Bq/L)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8\times°C)+32$$

Abbreviated units used in this report: µS/cm at 25 °C (microsiemens per centimeter at 25 °C); mg/L (milligrams per liter); µg/L (micrograms per liter); µm (micrometer); mrem/yr (millirem per year).

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Abstract

The U.S. Geological Survey and the Idaho Department of Water Resources, in cooperation with the U.S. Department of Energy, sampled water from 14 sites as part of an ongoing study to monitor the water quality of the eastern Snake River Plain aquifer between the southern boundary of the Idaho National Laboratory (INL) and the Burley-Twin Falls-Hagerman area. The State of Idaho, Department of Environmental Quality, Division of INL Oversight and Radiation Control cosampled with the U.S. Geological Survey and the Idaho Department of Water Resources and their analytical results are included in this report. The samples were collected from four domestic wells, two dairy wells, two springs, four irrigation wells, one observation well, and one stock well and analyzed for selected radiochemical and chemical constituents. Two quality-assurance samples, sequential replicates, also were collected and analyzed.

None of the concentrations of radiochemical or organic-chemical constituents exceeded the maximum contaminant levels for drinking water established by the U.S. Environmental Protection Agency. However, the concentration of one inorganic-chemical constituent, nitrate (as nitrogen), in water from site MV-43 was 20 milligrams per liter which exceeded the maximum contaminant level for that constituent. Of the radiochemical and chemical concentrations analyzed for in the replicate-sample pairs, 267 of the 270 pairs (with 95 percent confidence) were statistically equivalent.

Introduction

The Idaho National Laboratory (INL), a U.S. Department of Energy (DOE) facility, lies above the north-central part of the eastern Snake River Plain (ESRP) aquifer (fig. 1). Since the early 1950's, waste and wastewater from nuclear industrial processes have been disposed of and discharged to the subsurface at the INL. Until 1984, wastewater containing radiochemical and chemical wastes generated at the INL was discharged to ponds and wells. Since 1984 most wastewater has been discharged to infiltration ponds (Pittman and others, 1988, p. 20). Currently, wastewater is discharged to infiltration ponds or lined evaporation ponds in accordance with appropriate wastewater-discharge permits.

Because ground water from the ESRP aquifer supplies southeastern Idaho with a large water supply for domestic and industrial uses, wastewater-disposal practices at the INL have led to public concern about effects of these practices on water quality of the ESRP aquifer in areas downgradient from the INL. In response to the public concern, the DOE requested that the U.S. Geological Survey (USGS) conduct studies of the water quality of the aquifer between the southern boundary of the INL and the Burley-Twin Falls-Hagerman area (fig. 2). An initial water-quality study was designed to determine concentrations of tritium in ground water discharging from springs on the north side of the Snake River in the Twin Falls-Hagerman area. During the study, which lasted from 1988 to 2001, water samples were collected annually from selected springs and analyzed for tritium (Mann, 1989; Mann and Low, 1994; Bartholomay, Twining, and Campbell, 2001; Twining, 2002; Twining, Rattray, and Campbell, 2003). The study was discontinued after 2001 for budgetary reasons. A second water-quality study, conducted in 1989, consisted of collecting and analyzing ground-water samples in the eastern part of the A & B Irrigation District in Minidoka County for concentrations of radionuclides, trace metals, nutrients, and organic compounds. The results of this study were presented in a report by Mann and Knobel (1990). A third water-quality study, from which the results in this report are a part, is an ongoing annual sampling program between the southern boundary of the INL and the Burley-Twin Falls-Hagerman area. The study is being conducted by the USGS and the IDWR in cooperation with the DOE. The State of Idaho, Department of Environmental

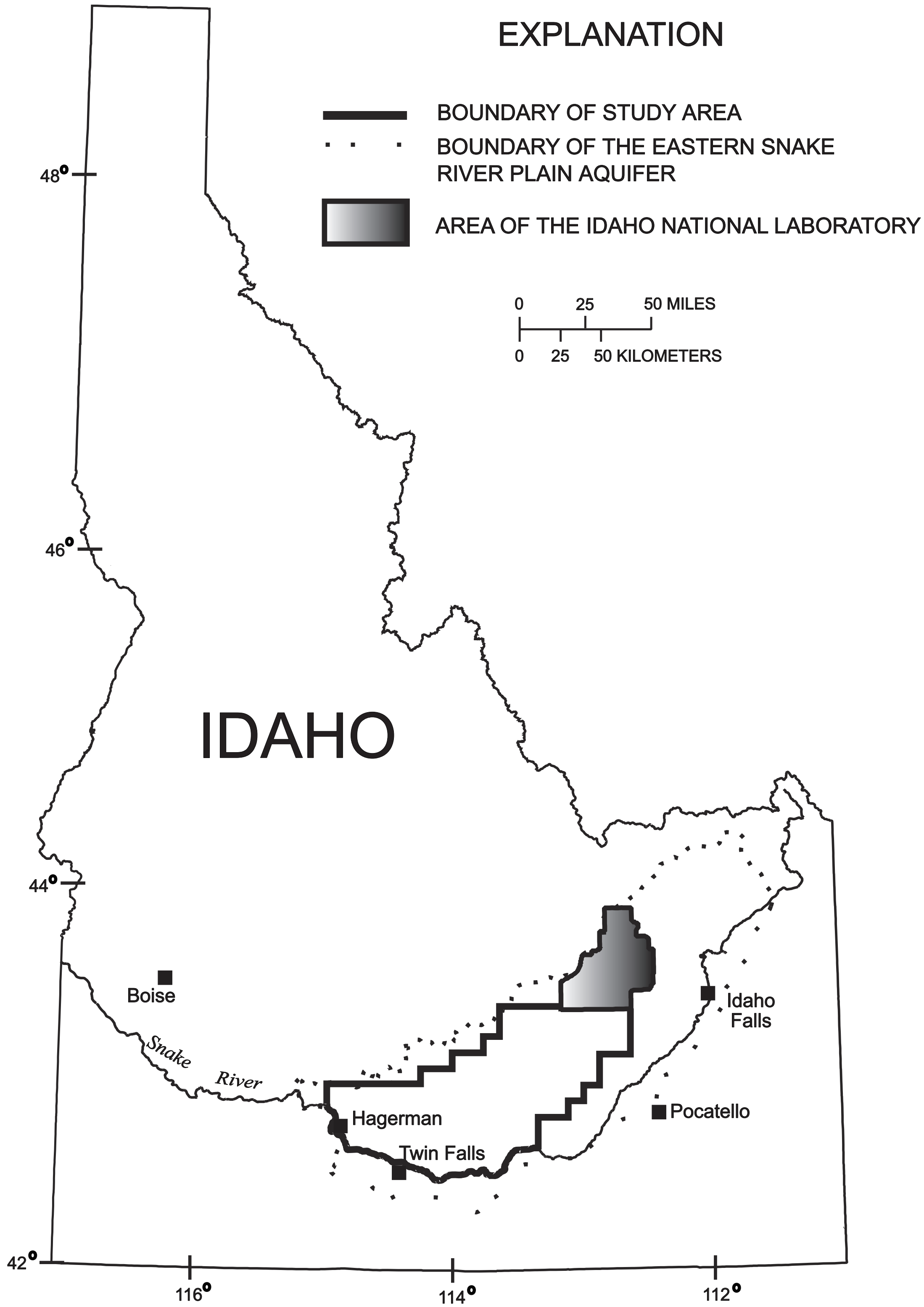

Figure 1. Map showing location of the study area, between the Idaho National Laboratory and Hagerman, Idaho

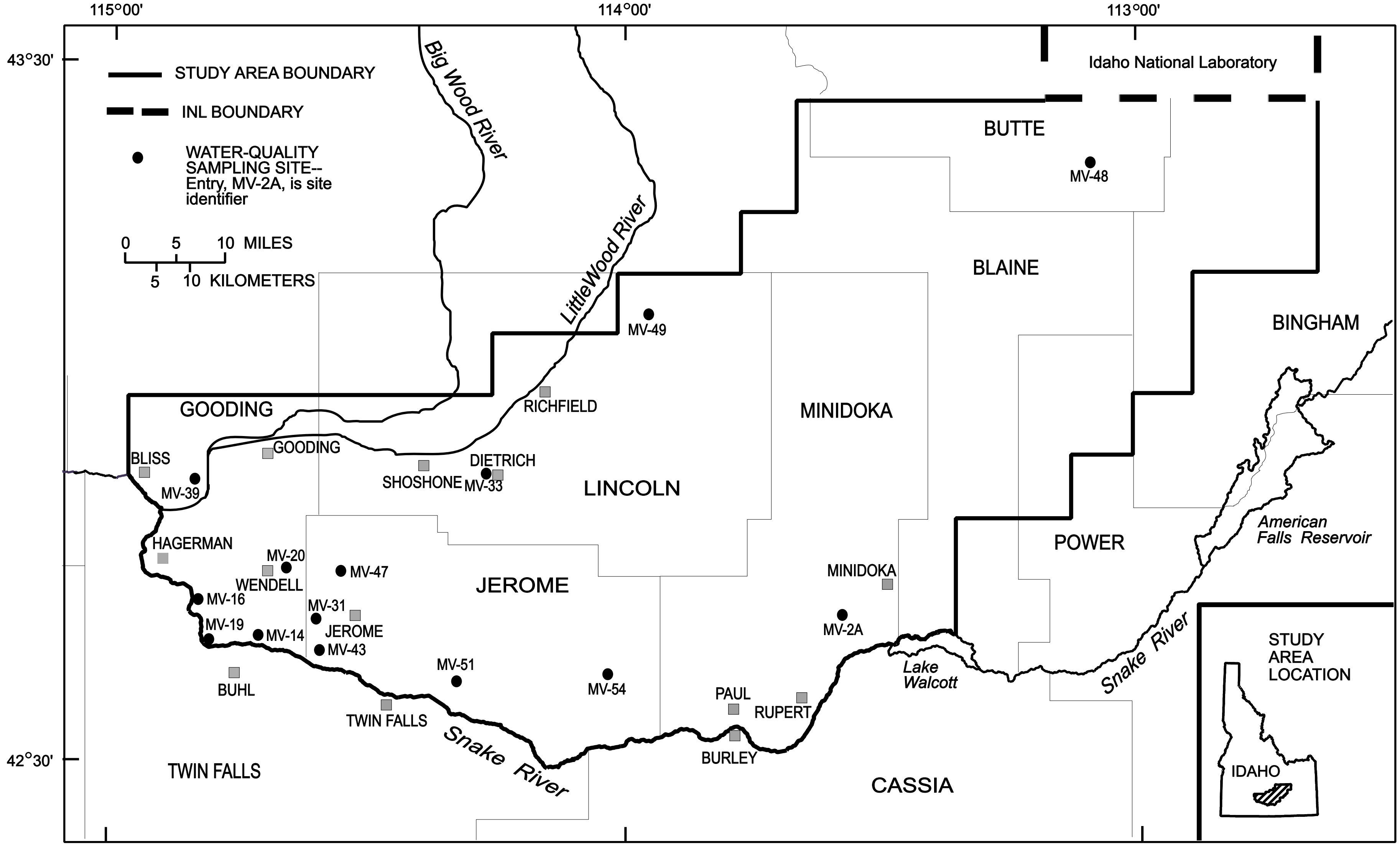

Figure 2. Map showing location of selected water-quality sampling sites in the study area.
Place mouse cursor over sample site location to display data.

Quality, Division of INL Oversight and Radiation Control (DEQ-INL) is cosampling with the USGS and IDWR in order to minimize the inconvenience to private well owners. Samples collected by the DEQ-INL are collected, preserved, and analyzed separately from USGS/IDWR samples. However, the DEQ-INL analytical results are presented in this report to facilitate comparison of USGS/IDWR and DEQ-INL results.

The initial round of sampling for the ongoing sampling program consisted of analyzing water samples collected from 55 sites during August and September 1989 for radionuclides, trace elements, nutrients, and organic compounds (Wegner and Campbell, 1991). Subsequent rounds of sampling have involved collecting water samples annually from about one-third of the original sites, so that all of the sites are sampled over a 3-year period, and analyzing them for the constituents listed above and for major cations and dissolved silica. In 2002, for budgetary reasons, the total number of sampling sites was reduced to 46. Because water-quality results from eliminated sites generally were similar to those of nearby sites preserved in the sampling program, the effect of fewer data-collection sites on representativeness of water-quality information is expected to be negligible. The analytical results from each sampling round were published in reports by Bartholomay, Edwards, and Campbell (1992, 1993, 1994a, 1994b); Bartholomay, Williams, and Campbell (1995, 1996, 1997b, 1998); Bartholomay, Twining, and Campbell (1999, 2000, 2001); Twining, Rattray, and Campbell (2003), and Rattray and Campbell (2004). An evaluation of the results from this study from 1989 through 1992 was published by Bartholomay, Williams, and Campbell (1997a). This report presents radiochemical and chemical data from the 2003 sampling round.

Water samples were collected by the USGS from 14 sites in 2003 (fig. 2) and analyzed by the USGS National Water Quality Laboratory (NWQL) in Lakewood, Colo., for radiochemical constituents, trace elements, major cations, dissolved silica, nutrients, purgeable organic compounds, insecticides, and herbicides. Water samples also were collected by the DEQ-INL and sent to the Environmental Monitoring Laboratory at Idaho State University (ISU-EML) in Pocatello, Idaho, for radionuclide analyses. Two quality-assurance (QA) samples, both sequential replicates, also were collected and analyzed.

Geohydrologic Setting

The ESRP is a northeast-trending structural basin about 200 mi long and 50 to 70 mi wide. The basin, bounded by faults on the northwest and downwarping and faulting on the southeast, has been filled with basaltic lava flows interbedded with terrestrial sediments (Whitehead, 1986). Thickness of individual basalt flows averages 20 to 25 ft, and aggregate thickness is as much as several thousand feet in places. Alluvial fan deposits are composed primarily of sand and gravel whereas, in areas where streams were dammed by basalt flows, the sediments are predominantly silt and clay (Garabedian, 1986). Rhyolitic lava rocks and tuffs are exposed locally at the surface and may exist at depth under most of the eastern plain. A 10,365-ft-deep test hole at the INL penetrated about 2,160 ft of basalt and sediment and 8,205 ft of tuffaceous and rhyolitic volcanic rocks (Mann, 1986).

The ESRP aquifer is recharged by seepage from the upper reaches of the Snake River, tributaries and canals, infiltration from irrigation and precipitation, and underflow from tributary valleys on the perimeter of the plain. Discharge from the aquifer is primarily a result of pumpage for irrigation and spring flow to the Snake River (Mann and Knobel, 1990). Discharge from springs in the ESRP has fluctuated during the nearly 100 years of flow-monitoring as a result of changes in water use, irrigation practices, and precipitation (Kjelstrom, 1992, p. 2).

Movement of water in the aquifer generally is from the northeast to southwest. Water moves horizontally through basalt interflow zones and vertically through joints and interfingering edges of the interflow zones. Infiltration of surface water, heavy pumpage, geologic conditions, and seasonal fluxes of recharge and discharge locally affect the movement of ground water (Garabedian, 1986).

Acknowledgments

The authors thank the well owners for granting permission to collect the water samples. The authors are grateful for technical review of the manuscript by Steven R. Anderson of the USGS and Kimberly Kaiser of the DEQ-INL.

Methods and Quality Assurance

The methods used in sampling and analyzing for selected chemicals followed the guidelines established by the USGS (Goerlitz and Brown, 1972; Stevens and others, 1975; Wood, 1981; Claassen, 1982; W.L. Bradford, USGS, written commun., 1985; Wershaw and others, 1987; Fishman and Friedman, 1989; Faires, 1992; Fishman, 1993; Zaugg and others, 1995; and Wilde and others, 1998, 1999, 2002). The methods used in the field and QA practices are described in the following sections.

Site Selection

Water samples were collected at 14 sites (fig. 2). The sites included four domestic wells, two dairy wells, two springs, four irrigation wells, one observation well, and one stock well. Criteria for site selection were geographic location, ease of sample collection, and long-term access.

Sample Containers and Preservatives

Sample containers and preservatives differ depending on the constituent(s) to be analyzed. Water samples analyzed by

the NWQL were collected and preserved in accordance with laboratory requirements specified by Timme (1995). Water samples analyzed by the ISU-EML were collected in accordance with the DEQ-INL sample-collection procedures (Hall, 2002). Sample containers, preservatives, and other treatments are summarized in table 1.

Sample Collection

Irrigation wells were sampled from spigots in discharge lines or from stilling ponds at the pump discharge point. A peristaltic pump was used to transfer water from the stilling pond to sample bottles. Domestic, dairy, and stock wells were sampled from spigots closest to the pumps. The observation well was sampled from a 1/4-in. sample port connected to the discharge line. All the wells either were pumping on arrival of the sampling team or were started on arrival and pumped long enough to ensure that pressure tanks and pumping systems had been thoroughly flushed as evidenced by stable pH, specific conductance, and water-temperature measurements. The springs were sampled as near the source as possible, and a peristaltic pump was used to fill the sample bottles with water from the springs.

Chemical and physical characteristics monitored at the sample-collection sites included pH, specific conductance, and water temperature. These characteristics were monitored during pumping using methods described by Wood (1981) and Hardy and others (1989). Water samples were collected after measurements of these characteristics indicated probable physical and chemical stability. After collection, sample containers were sealed with laboratory film, labeled, and packed into ice chests for shipment to the NWQL. The samples collected for analyses by the ISU-EML were stored until they were hand-delivered to the laboratory.

The sites sampled, site types, sample-collection dates, and field measurements of pH, specific conductance, and water temperature are shown in table 2. These measurements ranged from 7.1 to 8.0 for pH, from 312 to 964 μS/cm for specific conductance, and from 11.0 to 16.9 °C for water temperature.

Conditions at the sampling site during sample collection were recorded in a field logbook, and a chain-of-custody record was used to track the samples from the time of collection until delivery to the analyzing laboratory. These records are available for inspection at the USGS INL Project Office. Records for samples analyzed by the ISU-EML are maintained at the ISU laboratory.

Quality Assurance

Water samples analyzed by the NWQL were collected and handled in accordance with a QA plan for quality-of-water activities conducted by personnel at the INL Project Office. The plan was finalized in June 1989, revised in 1992, 1996 (Mann, 1996), and 2003 (Bartholomay and others, 2003) and is available for inspection at the USGS INL Project Office. Internal quality control (QC) and overall QA practices used by the NWQL were described in reports by Friedman and Erdmann (1982), Jones (1987), and Pritt and Raese (1995). Water samples analyzed by the DEQ-INL were collected and handled in accordance with procedures described by Hall (2002).

The bias and precision of the field and laboratory methods used for this study are evaluated through the collection and analysis of field and source blanks and replicate samples. Quality-assurance samples have been collected during every sampling round and make up about 10 percent of the water samples collected in this sampling program. A report by Williams and others (1998) presented an evaluation of the QA/QC results from this study for samples collected between 1989 through 1995. In 2003, two QA samples, MV-28 and -34, were collected. These samples were sequential replicates of MV-14 and -48. An evaluation of the statistical equivalency of constituent concentrations in these replicate-sample pairs is presented in the section, Statistical Equivalency of the Replicate Pair of Samples. The DEQ-INL will publish a statistical comparison of analytical results from duplicate water samples collected by the USGS and the DEQ-INL in their 2004 Environmental Surveillance Report.

Radiochemical Constituents

Water samples were analyzed for tritium, strontium-90, gross alpha-particle and gross beta-particle radioactivity, and the gamma-emitting radionuclides cesium-137 and potassium-40. The samples were analyzed using methods described by Thatcher and others (1977). The U.S. Environmental Protection Agency (EPA) maximum contaminant levels (MCL's) for selected radionuclides and types of radioactivity in drinking water are listed in table 3.

An analytical uncertainty, **s**, is calculated by the analyzing laboratory for each radionuclide concentration or radioactivity measurement. This report presents the analytical uncertainty as 2**s**. Guidelines for interpreting analytical results are based on an extension of the method described by Currie (1984). In radiochemical analyses, laboratory measurements are made on a target sample and a prepared blank. Instrument signals for the sample and blank vary randomly. Therefore, it is essential to distinguish between two aspects of the problem of detection: (1) the instrument signal for the sample must be greater than the signal for the blank to make the decision that there was detection; and (2) an estimation must be made of the minimum concentration that will yield a sufficiently large signal to make the correct decision for detection or nondetection most of the time. The first aspect of the problem is a qualitative decision based on signals and a definite criterion for detection. The second aspect of the problem is an estimation of the detection capabilities of a complete measurement process that includes hypothesis testing.

For radionuclide analyses in this sampling program, the critical level for detection of a constituent is defined as 1.6**s**. A radionuclide concentration or radioactivity measurement that is above this critical level is determined as being detected in the sample. Given a large number of samples, as many as 5 percent of the samples with measured concentrations equal to or greater than 1.6**s**, which were determined as containing the radionuclide or radioactivity, might not contain the radioactive constituent. These measurements are referred to as false positives and are errors of the first type in hypothesis testing.

A concentration that equals 3**s** represents a measurement at the minimum detectable concentration. For samples containing a true concentration of 3**s** or greater, there is a 95-percent-or-more probability that the radioactive constituent will be determined as being present in the sample. Given a large number of samples, as many as 5 percent of the samples with true concentrations greater than or equal to 3**s** could be determined as not containing the radionuclide or radioactivity. These measurements are referred to as false negatives and are errors of the second type in hypothesis testing.

More false-negative than false-positive measurements are made on samples containing true radionuclide concentrations between 1.6 **s** and 3**s**, and there is a greater-than-5-percent probability of false-negative results for these samples. At 1.6**s**, the probability of a false negative is about 50 percent.

These guidelines are based on counting statistics alone and do not include systematic or random errors inherent in laboratory procedures. The values 1.6**s** and 3**s** vary slightly with background or blank counts and with the number of gross counts for individual analyses. The use of the critical level and minimum detectable concentration aids the reader in the interpretation of analytical results and does not represent absolute concentrations of radioactivity that may or may not have been detected. In this report, if the concentration of a selected radionuclide was equal to or greater than 3**s**, the concentration was considered to be above a "reporting level." The reporting level should not be confused with the analytical method detection limit, which is based on laboratory procedures. At small concentrations, the reporting level approaches the analytical method detection limit; however, at larger concentrations, they may be significantly different.

Many analytical results of environmental radioactivity measurements are at or near zero. If the true concentration for a given radionuclide is zero, a given set of analytical results for that radionuclide should be distributed about zero, with an equal number of negative and positive measurements. Negative analytical results occur if the radioactivity measured in a water sample is less than the radioactivity measured in a background or blank sample (American Society for Testing and Materials, 1992, p. 126; Knobel and others, 1992, p. 51).

Tritium

Tritium, a radioactive isotope of hydrogen, is formed in nature by interactions of cosmic rays with gases in the upper atmosphere. Tritium also is produced in thermonuclear detonations and is a waste product of nuclear industrial processes. By 1961, discharge of industrial wastewater at the INL had resulted in tritium concentrations in the aquifer that exceeded the 20,000 pCi/L MCL for tritium (table 3) (Mann and Cecil, 1990). Since 1961, tritium concentrations in the aquifer generally have decreased (Mann and Cecil, 1990) and, by 1998, tritium concentrations in all aquifer samples collected from the INL by the USGS were less than the MCL (Bartholomay, Tucker, Davis, and Greene, 2000). While concentrations of tritium were decreasing, the areal distribution of tritium in the aquifer was increasing. By 1983, 31 years after disposal of tritium in wastewater was initiated at the INL, tritium had been detected in water from wells along the southern boundary of the INL, 8 to 9 mi south of the discharge location (Pittman and others, 1988). This transport distance corresponds to an apparent transport velocity for tritium of about 4 ft per day.

Ground-water samples collected in the study area in 2003 for tritium analysis were submitted to the NWQL and the ISU-EML. The NWQL and the ISU-EML both use an electrolytic-enrichment liquid-scintillation counting method. The ISU-EML also performs a second set of analyses using a standard liquid-scintillation counting method. The analytical method detection limit for the NWQL was 1 pCi/L for a 1,000-minute counting period. The analytical method detection limits for the ISU-EML were 150 pCi/L (standard method) and less than 25 pCi/L (enrichment method) for 200-minute counting periods.

Concentrations of tritium in water samples analyzed by the NWQL ranged from 3.5±1.0 to 38.1±2.6 pCi/L. All of the concentrations were greater than the reporting level (table 4). Concentrations of tritium in water samples analyzed by the ISU-EML using the enrichment method ranged from 3±5 to 36±8 pCi/L. Thirteen of the concentrations were greater than the reporting level (table 4). Background concentrations of tritium in ground water in Idaho generally range from 0 to 40 pCi/L (Knobel and others, 1992).

Strontium-90

Strontium-90 is a fission product that was widely distributed in the environment during atmospheric weapons tests. Strontium-90 generally is present in ground water as a result of these tests and from nuclear industry waste-disposal practices. Because strontium-90 adsorbs onto sediment material in the aquifer, it is not expected to move past its current location at the INL (Bartholomay, 1998). Concentrations of strontium-90 ranged from -0.13±0.10 to 0.02±0.08 pCi/L (table 4). All of the concentrations were less than the reporting level. The MCL for strontium-90 is 8 pCi/L (table 3).

Gross Alpha-Particle Radioactivity

Gross alpha-particle radioactivity is a measure of the total radioactivity given off as alpha particles during the radioac-

tive decay process. However, laboratories generally report the radioactivity as if it were all given off by one radionuclide. In this report, concentrations in pCi/L are reported as dissolved thorium-230 by the NWQL and as total thorium-230 by the ISU-EML.

The concentrations of gross alpha-particle radioactivity in water samples analyzed by the NWQL ranged from -4.14±1.62 to 2.44±1.76 pCi/L. Five of the concentrations were greater than the reporting level (table 5). Concentrations of gross alpha-particle radioactivity in water samples analyzed by the ISU-EML ranged from -0.1±1.5 to 5.6±1.7 pCi/L. Three of the concentrations were greater than the reporting level (table 5). The largest concentration reported, 5.6±1.7 pCi/L, was less than the 15 pCi/L MCL for gross alpha-particle radioactivity (table 3).

Gross Beta-Particle Radioactivity

Gross beta-particle radioactivity is a measure of the total radioactivity given off as beta particles during the radioactive decay process. Laboratories generally report this radioactivity as if it were all given off by one radionuclide. In this report, concentrations of gross beta-particle radioactivity in pCi/L are reported as dissolved cesium-137 by the NWQL and as total cesium-137 by the ISU-EML. The MCL for gross beta-particle and gamma radioactivity is 4 mrem/yr (table 3), and an average annual concentration of cesium-137 in public drinking-water supplies of 200 pCi/L is assumed to produce a 4-mrem/yr dose of beta-particle radioactivity (U.S. Environmental Protection Agency, 1977).

Fifteen of the concentrations of gross beta-particle radioactivity in the water samples analyzed by the NWQL were greater than the reporting level (table 5), and the concentrations in all samples ranged from -2.18±1.56 to 11.9±3.4 pCi/L. Concentrations of gross beta-particle radioactivity in water samples analyzed by the ISU-EML ranged from 0.7±0.8 to 7.4±0.9 pCi/L. Twelve of the concentrations were greater than the reporting level (table 5).

Cesium-137 and Potassium-40

Concentrations of cesium-137 and potassium-40 in the water samples were determined using gamma spectroscopy. Cesium-137 is a fission product of uranium-235, uranium-233, or plutonium-239. Potassium makes up approximately 2.6 percent of the Earth's continental crust, and 0.0118 percent of all potassium is the naturally occurring radioactive isotope potassium-40 (Eisenbud and Gesell, 1997).

Concentrations of cesium-137 and potassium-40 in water samples ranged from -1.2±2.2 to 1±1.7 pCi/L and -50±45 to 35±43 pCi/L, respectively. All of the concentrations were less than the reporting level (table 6). The MCL for cesium-137 is 200 pCi/L.

Chemical Constituents

Water samples were analyzed for the following selected chemical constituents: trace elements, major cations, dissolved silica, nutrients, purgeable organic compounds, insecticides, and herbicides. Minimum reporting levels (MRL's), laboratory reporting levels (LRL's), and long-term method detection limits (LT-MDL's) were used to determine when a chemical constituent was detected with sufficient confidence.

The MRL is the smallest measured concentration of a constituent that can be reliably reported using a given analytical method (Timme, 1995). In this report, MRL's are used only in reporting concentrations of purgeable organic compounds. The LRL is determined such that "the probability of falsely reporting a non-detection for a sample that contained an analyte at a concentration equal to or greater than the LRL is predicted to be less than or equal to 1 percent" (Childress and others, 1999, p. 19). Falsely reporting a nondetection is known as a false negative and is an error of the second type in hypothesis testing. The LT-MDL is determined by calculating the standard deviation of a large sample population (at least 24 measurements) of spiked-sample measurements over an extended period of time (often one year). The probability "of falsely reporting a concentration at or greater than the LT-MDL for a sample that did not contain the analyte is predicted to be less than or equal to 1 percent" (Childress and others, 1999, p. 19). Falsely reporting a detection is known as a false positive and is an error of the first type in hypothesis testing.

Trace Elements

Water samples were analyzed for selected trace elements including barium, chromium, iron, lead, lithium, manganese, mercury, strontium, and zinc. The maximum or secondary MCL's and LRL's for these trace elements are shown in table 7 and the measured concentrations are shown in table 8.

Barium.—Concentrations of barium ranged from 14 to 127 µg/L. All of these concentrations were greater than the LRL of 2 µg/L. The MCL for barium is 2,000 µg/L.

Chromium.—Concentrations of chromium in 12 of the samples were greater than the LRL of 0.8 µg/L. Concentrations ranged from an estimated 0.6 to 2.5 µg/L. The MCL for chromium is 100 µg/L.

Iron.—Concentrations of iron in 14 of the 16 samples were less than the LRL of 8 µg/L. The concentrations ranged from an estimated 5.7 to 14 µg/L. The secondary MCL for iron is 300 µg/L.

Lead.—Concentrations of lead in three samples ranged from an estimated 0.7 to 1.0 µg/L. None of the concentrations exceeded the LRL of 1 µg/L. Lead has an EPA action level of 15 µg/L.

Lithium.—Concentrations of lithium in 13 samples were greater than the LRL of 3 µg/L. The concentrations ranged from an estimated 1.7 to 52 µg/L. There is no established MCL for lithium.

Manganese.—Concentrations of manganese ranged from an estimated 0.2 to 19 μg/L, and concentrations in five samples were greater than or equal to the LRL of 0.4 μg/L. The secondary MCL for manganese is 50 μg/L.

Mercury.—Concentrations of mercury in all samples were less than the LRL of 0.018 μg/L. The MCL for mercury is 2 μg/L.

Strontium.—Concentrations of strontium in all samples were greater than the LRL of 0.4 μg/L and ranged from 166 to 536 μg/L. There is no established MCL for strontium.

Zinc.—Concentrations of zinc in nine samples ranged from an estimated 1.7 to 392 μg/L. All other concentrations were less than the LRL for zinc of 3 μg/L. The secondary MCL for zinc is 5,000 μg/L.

Major Cations and Dissolved Silica

Water samples were analyzed for major cations (calcium, magnesium, and sodium) and dissolved silica. The LRL's for these constituents are shown in table 9 and the measured concentrations are shown in table 10. There are no established MCL's for these constituents.

Calcium.—Concentrations of calcium in all samples were greater than the LRL of 0.011 mg/L and ranged from 28 to 103 mg/L.

Magnesium.—Concentrations of magnesium in all samples were greater than the LRL of 0.008 mg/L and ranged from 15 to 38 mg/L.

Sodium.—Concentrations of sodium in all samples were greater than the LRL of 0.1 mg/L and ranged from 8.0 to 51 mg/L.

Dissolved Silica.—Concentrations of dissolved silica in all samples were greater than the LRL of 0.2 mg/L and ranged from 23 to 44 mg/L.

Nutrients

Water samples were analyzed for ammonia (as nitrogen), nitrite (as nitrogen), nitrite plus nitrate (as nitrogen), and orthophosphate (as phosphorus). The MCL's and the LRL's are shown in table 9 and the measured concentrations are shown in table 10.

Ammonia (as nitrogen).—Concentrations of ammonia (as nitrogen) in all samples were less than the laboratory reporting level of 0.041 mg/L.

Nitrite (as nitrogen).—Concentrations of nitrite (as nitrogen) in all samples were less than the LRL of 0.008 mg/L. The MCL for nitrite is 1 mg/L.

Nitrite plus nitrate (as nitrogen).—Concentrations of nitrite plus nitrate (as nitrogen) in all samples were greater than the LRL of 0.06 mg/L and ranged from 0.6 to 20 mg/L. The concentration in sample MV-43 of 20 mg/L was greater than the MCL for nitrate (as nitrogen) of 10 mg/L. Concentrations in all other sample were less than the MCL.

Orthophosphate (as phosphorus).—Concentrations of orthophosphate (as phosphorus) in all samples were less than the LRL for orthophosphate of 0.18 mg/L.

Purgeable Organic Compounds

Water samples were analyzed for concentrations of 61 purgeable organic compounds. The MCL's and MRL's for these compounds are shown in table 11. Concentrations of all purgeable organic compounds in the water samples were less than the respective MCL's and equal to or less than the respective MRL's.

Insecticides

Water samples were analyzed for concentrations of 19 insecticides. The MCL's, LRL's, and LT-MDL's for these compounds are shown in table 12. Concentrations of all insecticides in the water samples were less than the respective MCL's and LRL's.

Herbicides

Water samples were analyzed for concentrations of 28 herbicides. The MCL's, LRL's, and LT-MDL's for these compounds are shown in table 13. Estimated and reported concentrations ranged from 0.006 to 0.011 μg/L for atrazine, 0.004 to 0.019 μg/L for deethyl atrazine, and 0.005 to 0.039 μg/L for metribuzin (table 14). All estimated and reported concentrations of atrazine were less than the MCL for atrazine. No MCL's have been established for deethyl atrazine or metribuzin. All concentrations of other herbicides in the water samples were less than the respective MCL's and LRL's.

Statistical Equivalency of the Replicate Pair of Samples

The statistical equivalency of chemical-constituent concentrations in the replicate-sample pairs was determined following the method outlined by Williams (1996). In this method, statistical equivalence is determined within a specified confidence level. A value for the standard deviate, Z, is calculated, and then the level of significance of the result is evaluated (evaluation of the level of significance assumes that the sample population is distributed normally). For this report, concentrations in replicate samples were considered equivalent when the results were within two standard deviations of each other. At this confidence level (95-percent), the level of significance, determined from a standard normal probability curve, was 0.05 for a two-tailed test and corresponded to a Z-value of 1.96.

The equation used to determine Z was adapted from Volk (1969):

$$Z = \frac{|x - y|}{\sqrt{(s_x)^2 + (s_y)^2}} \qquad (1)$$

where
x is the concentration in the routine sample,
y is the concentration in the sequential replicate sample,
s_x is the standard deviation of x, and
s_y is the standard deviation of y.

The standard deviations used in equation 1 were calculated by the analyzing laboratory for radionuclides and approximated from NWQL-determined most probable deviations for inorganic constituents (Ted Struzeski, NWQL, written commun., 2003) and relative standard deviations for organic constituents (Donna Rose and Jim Madsen, NWQL, written communs., 2004).

Constituent concentrations in the replicate-sample pairs were considered statistically equivalent when the calculated Z-value was less than or equal to 1.96. Constituent concentrations also were considered statistically equivalent, although Z-values were not calculated, when the concentration in both samples was reported as less than the LRL or MRL. Of the 270 pairs (with 95 percent confidence) of radiochemical and chemical concentrations analyzed for in the replicate samples, 267 were statistically equivalent. Constituent concentrations that were not statistically equivalent included the gross beta-particle radioactivity in sample pair MV-14 and -28 (Z-value = 5.97) analyzed by NWQL and the gross alpha-particle radioactivity and potassium-40 in sample pair MV-34 and -48 (Z-values = 1.98 and 2.14, respectively) analyzed by ISU-EML.

Summary

The U.S. Geological Survey and the Idaho Department of Water Resources, in cooperation with the U.S. Department of Energy, sampled water from 14 sites as part of an ongoing study to monitor the water quality of the eastern Snake River Plain aquifer between the southern boundary of the Idaho National Laboratory (INL) and the Burley-Twin Falls-Hagerman area. The State of Idaho, Department of Environmental Quality, Division of INL Oversight and Radiation Control cosampled with the U.S. Geological Survey and the Idaho Department of Water Resources and their analytical results are included in this report. The samples were collected from four domestic wells, two dairy wells, two springs, four irrigation wells, one observation well, and one stock well and analyzed for selected radiochemical and chemical constituents. Two quality-assurance samples, sequential replicates, also were collected and analyzed.

Concentrations of radionuclides in water samples ranged from 3±5 to 38.1±2.6 picocuries per liter (pCi/L) for tritium (electrolytic enrichment technique), from -0.13±0.10 to 0.02±0.08 pCi/L for strontium-90, from -4.14±1.62 to 5.6±1.7 pCi/L for gross alpha-particle radioactivity (reported as dissolved or total thorium-230), from -2.18±1.56 to 11.9±3.4 pCi/L for gross beta-particle radioactivity (reported as dissolved cesium-137), from -1.2±2.2 to 1±1.7 pCi/L for cesium-137, and from -50±45 to 35±43 pCi/L for potassium-40. None of these sample concentrations exceeded a U.S. Environmental Protection Agency maximum contaminant level (MCL) for drinking water.

Concentrations of trace elements in the water samples ranged from 14 to 127 micrograms per liter (μg/L) for barium, from 0.6 to 2.5 μg/L for chromium, from 5.7 to 14 μg/L for iron, from 0.7 to 1.0 μg/L for lead, from 1.7 to 52 μg/L for lithium, from 0.2 to 19 μg/L for manganese, from 166 to 536 μg/L for strontium, and from 1.7 to 392 μg/L for zinc. The concentrations of mercury in all samples were less than 0.018 μg/L. Concentrations of major cations and dissolved silica in the water samples ranged from 28 to 103 milligrams per liter (mg/L) for calcium, from 15 to 38 mg/L for magnesium, from 8.0 to 51 mg/L for sodium, and from 23 to 44 mg/L for dissolved silica. Nutrient concentrations in water samples were less than 0.041 mg/L for ammonia (as nitrogen), less than 0.008 mg/L for nitrite (as nitrogen), and less than 0.18 mg/L for orthophosphate (as phosphorus). Concentrations of nitrite plus nitrate (as nitrogen) ranged from 0.6 to 20 mg/L, and the concentration of 20 mg/L in sample MV-43 exceeded the MCL for nitrate (as nitrogen) of 10 mg/L. All concentrations of trace elements, major cations, dissolved silica, and other nutrients in the water samples were less than the respective MCL's.

Concentrations of all purgeable organic compounds in the water samples were equal to or less than the respective MRL's, and concentrations of all insecticides in the water samples were equal to or less than the respective LRL's. Measured or estimated concentrations of three herbicides were greater than the respective LRL's. Concentrations of these herbicides ranged from 0.006 to 0.011 μg/L for atrazine, from 0.004 to 0.019 μg/L for deethyl atrazine, and from 0.005 to 0.039 μg/L for metribuzin. None of the concentrations of purgeable organic compounds, insecticides, or herbicides exceeded an established MCL for drinking water.

All of the constituent concentrations in the replicate-sample pairs analyzed by the NWQL, with the exception of concentrations of gross beta-particle radioactivity in sample pair MV-14 and -28 (Z-value = 5.97), were statistically equivalent. The replicate-sample pairs analyzed by the ISU-EML were statistically equivalent for the concentrations of tritium, gross beta-particle radioactivity, and cesium-137, but were not statistically equivalent for concentrations of gross alpha-particle radioactivity and potassium-40 in sample pair MV-34 and -48. The Z-values for these concentrations were 1.98 and 2.14, respectively. Of the radiochemical and chemical concentrations analyzed for in the replicate-sample pairs, 267 of the 270 pairs (with 95 percent confidence) were statistically equivalent.

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Tables

Table 1. Containers and preservatives used for water-sample collection

[Abbreviations: L, liter; mL, milliliter; µm, micrometer; °C, degrees Celsius. Chemical formulas: HNO_3, nitric acid; HCl, hydrochloric acid. Chilled samples were shipped by overnight-delivery mail. Analyzing laboratory: NWQL, U.S. Geological Survey National Water Quality Laboratory; ISU-EML, Idaho State University Environmental Monitoring Laboratory]

Constituent or type of constituent	Container		Preservative		Other treatment	Analyzing laboratory
	Type	Size	Type	Size		
Tritium	Polyethylene	1 L	None	None	None	NWQL
	Polyethylene	1 L	None	None	None	ISU-EML
Strontium-90	Polyethylene, acid rinsed	1 L	HNO_3	4 mL	.45-µm filter	NWQL
Gross alpha- and beta-particle, cesium-137, potassium-40	Polyethylene, acid rinsed	2 L	HNO_3	4 mL	.45-µm filter	NWQL
	Polyethylene	2 L	None	None	None	ISU-EML
Trace elements, major cations and dissolved silica	Polyethylene, acid rinsed	250 mL	HNO_3	2 mL	.45-µm filter	NWQL
	Polyethylene	250 mL	None	None	.45-µm filter	NWQL
	Polyethylene	250 mL	None	None	None	NWQL
Mercury	Glass, acid rinsed	250 mL	HCl	2 mL	.45-µm filter	NWQL
Nutrients	Polyethylene, brown	125 mL	None	None	.45-µm filter, chill 4 °C	NWQL
Purgeable organic compounds	Glass, amber, septum vial	40 mL	None	None	Chill 4 °C	NWQL
Insecticides and herbicides	Glass, amber, baked	1 L	None	None	Chill 4 °C	NWQL

Table 2. Results of field measurements of water for pH, specific conductance, and temperature from selected wells and springs, eastern Snake River Plain

See figure 2 for location of sites. Site type: H, domestic; D, dairy; Sp, spring; I, irrigation; QA, quality assurance; O, observation; S, stock. Date sampled: month/day/year. Units: pH, negative base-10 logarithm of hydrogen-ion activity in moles per liter; specific conductance, microsiemens per centimeter (µS/cm) at 25 °C (degrees Celsius); temperature in degrees Celcius, °C. The National Secondary Drinking Water Standard for pH is 6.5-8.5 (U.S. Environmental Protection Agency, 2003). Symbol: *, quality-assurance sample (MV-28 and -34 are replicates of MV-14 and -48, respectively)]

Site identifier	Site ID	Site type	Date sampled	pH	Specific conductance (µS/cm at 25 °C)	Temperature (°C)
MV-2A	424322113342902	H	8/11/03	7.7	560	15.6
MV-14	424118114435501	D	8/12/03	7.4	558	14.4
MV-16	13132600	Sp	8/12/03	7.3	383	14.5
MV-19	13095175	Sp	8/12/03	7.1	487	14.6
MV-20	424608114391301	I	8/12/03	7.3	390	14.9
MV-28*	433000113000001	QA	8/12/03	7.4	558	14.4
MV-31	424301114364001	I	8/12/03	7.8	588	14.1
MV-33	425455114160101	H	8/13/03	7.5	312	16.6
MV-34*	433000113000001	QA	8/13/03	8.0	352	13.1
MV-39	425352114494601	I	8/12/03	7.1	650	14.4
MV-43	423958114343801	I	8/11/03	7.6	964	13.9
MV-47	424655114333401	D	8/11/03	7.8	354	15.0
MV-48	432336113064201	O	8/13/03	8.0	352	13.1
MV-49	430931113563401	S	8/14/03	7.7	382	11.0
MV-51	424643114192801	H	8/11/03	7.2	663	16.9
MV-54	423856114005601	H	8/11/03	7.8	776	14.9

Table 3. Maximum contaminant levels for selected radionuclides and types of radioactivity in drinking water

[The maximum contaminant levels (MCL's) were established pursuant to the recommendations of the U.S. Environmental Protection Agency (2003) for community water systems and are included for comparison with results from this study. MCL's shown for tritium, strontium-90, and cesium-137 are concentrations assumed to produce a total body or organ dose of 4 millirem per year (mrem/yr) of beta-particle radioactivity (U.S. Environmental Protection Agency, 1977). The MCL given for gross alpha-particle radioactivity excludes radon and uranium. Abbreviation: pCi/L, picocurie per liter]

Radionuclide or type of radioactivity	Maximum contaminant level
Tritium	20,000 pCi/L
Strontium-90	8 pCi/L
Gross alpha-particle radioactivity	15 pCi/L
Gross beta-particle and gamma radioactivity	4 mrem/yr
Cesium-137	200 pCi/L

Table 4. Concentrations of tritium and strontium-90 in water from selected wells and springs, eastern Snake River Plain

[See figure 2 for location of sites. Samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory (NWQL) and Idaho State University Environmental Monitoring Laboratory (ISU-EML) using the following methods: tritium by standard liquid-scintillation counting (ISU-EML) and electrolytic-enrichment liquid-scintillation counting (both laboratories); strontium-90 by gas proportional counting. Analytical results and uncertainties—for example 21.4±1.6—in picocuries per liter (pCi/L). Analytical uncertainties are reported as 2**s**. Concentrations that equal or exceed the reporting level of 3**s** are shown in boldface type. Symbol: *, quality-assurance sample (MV-28 and -34 are replicates of MV-14 and -48, respectively)]

Site identifier	Tritium, NWQL (Enrichment) (pCi/L)	Tritium, ISU-EML (Enrichment) (pCi/L)	Tritium, ISU-EML (Standard) (pCi/L)	Strontium-90, NWQL (pCi/L)
MV-2A	**21.4±1.6**	**22±6**	10±70	-0.02±0.09
MV-14	**15.4±1.3**	**13±6**	10±70	-.02±0.09
MV-16	**4.2±1.0**	**6±4**	20±49	.00±0.09
MV-19	**7.0±1.0**	6±6	10±70	-.06±0.09
MV-20	**8.3±1.0**	**10±6**	-20±70	-.09±0.09
MV-28*	**15.0±1.3**	**15±4**	20±70	-.04±0.08
MV-31	**21.2±1.6**	3±5	-30±70	-.02±0.11
MV-33	**6.1±1.0**	**11±4**	-5±49	-.13±0.10
MV-34*	**21.4±1.3**	**24±6**	30±70	-.06±0.08
MV-39	**27.5±1.9**	**35±6**	40±70	.02±0.08
MV-43	**38.1±2.6**	**36±8**	30±70	.00±0.08
MV-47	**3.5±1.0**	4±5	10±70	-.06±0.09
MV-48	**22.4±1.3**	**23±5**	10±70	-.05±0.11
MV-49	**32.6±1.9**	**29±6**	60±70	-.08±0.10
MV-51	**29.4±1.9**	**30±4**	50±49	-.01±0.08
MV-54	**36.2±2.6**	**29±6**	0±70	-.04±0.09

Table 5. Concentrations of gross alpha-particle and gross beta-particle radioactivity in water from selected wells and springs, eastern Snake River Plain

[See figure 2 for location of sites. Samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory (NWQL) and the Idaho State University Environmental Monitoring Laboratory (ISU-EML) using a residue procedure. Analytical results and uncertainties—for example 0.22±0.60—in picocuries per liter (pCi/L). Analytical uncertainties are reported as 2**s**. Concentrations that equal or exceed the reporting level of 3**s** are shown in boldface type. Symbols: *, quality-assurance sample (MV-28 and -34 are replicates of MV-14 and -48, respectively)]

Site identifier	Gross alpha-particle as dissolved thorium-230, NWQL (pCi/L)	Gross alpha-particle as total thorium-230, ISU-EML (pCi/L)	Gross beta-particle as dissolved cesium-137, NWQL (pCi/L)	Gross beta-particle as total cesium-137, ISU-EML (pCi/L)
MV-2A	0.22±0.60	1.4±2	**6.43±1.76**	**4.8±1**
MV-14	**1.52±0.98**	2.3±2	-2.18±1.56	**3.4±1**
MV-16	.83±0.68	.1±1.6	**3.39±1.08**	**2.6±0.9**
MV-19	.43±0.78	2.4±2	**4.47±1.66**	1.1±0.9
MV-20	.44±0.70	.7±1.1	**3.65±1.24**	**1.7±0.6**
MV-28*	**1.91±1.08**	1.2±2	**4.66±1.68**	**3.2±1**
MV-31	-4.14±1.62	1.7±2.1	**4.82±1.28**	**3±1**
MV-33	**.94±0.62**	.8±1.3	**3.38±0.98**	1±0.8
MV-34*	.70±0.62	1.1±1.5	**2.38±0.84**	.7±0.8
MV-39	1.83±1.26	**4.5±1.5**	**11.9±3.4**	**3.6±0.8**
MV-43	2.44±1.76	**5.6±1.7**	**8.8±2.4**	**7.4±0.9**
MV-47	**1.11±0.64**	-.1±1.5	**3.77±1.06**	**2.4±0.9**
MV-48	**.86±0.52**	**3.2±1.5**	**2.97±0.94**	**1.6±0.9**
MV-49	.23±0.46	2±1.5	**2.45±0.88**	1.1±0.9
MV-51	1.38±1.02	1.8±1.8	**6.94±1.98**	**1.8±1**
MV-54	-.81±1.02	1.9±1.7	**6.60±1.60**	**5.4±0.8**

Table 6. Concentrations of cesium-137 and potassium-40 in water from selected wells and springs, eastern Snake River Plain

[See figure 2 for location of sites. Samples were analyzed by the Idaho State University Environmental Monitoring Laboratory using gamma spectroscopy. Analytical results and uncertainties—for example 35±43—in picocuries per liter (pCi/L). Analytical uncertainties are reported as 2**s**. Symbol: *, quality-assurance sample (MV-28 and -34 are replicates of MV-14 and -48, respectively)]

Site identifier	Cesium-137 (pCi/L)	Potassium-40 (pCi/L)
MV-2A	-1.2±2.2	35±43
MV-14	-.1±1.3	-24±48
MV-16	.9±2.1	-19±42
MV-19	.5±1.3	-38±47
MV-20	.6±1.3	-2±34
MV-28*	.6±1.4	-8±39
MV-31	.5±1.5	-10±49
MV-33	-.9±1.3	-6±39
MV-34*	0±1.4	-44±48
MV-39	-.4±1.4	-1±30
MV-43	.5±1.6	10±40
MV-47	.6±1.6	-9±48
MV-48	.6±2.3	25±43
MV-49	1±1.7	31±50
MV-51	-.7±1.7	-50±45
MV-54	.1±.9	3±28

Table 7. Maximum or secondary maximum contaminant levels and laboratory reporting levels for selected trace elements in drinking water

[The maximum contaminant levels (MCL's) were established pursuant to the recommendations of the U.S. Environmental Protection Agency (2003) for community water systems and are included for comparison with results from this study. Secondary MCL's—in brackets—are from U.S. Environmental Protection Agency (2003). Units are in micrograms per liter (µg/L). Symbols: *, lead has an action level of 15 µg/L; **, MCL has not been established]

Trace elements	Maximum or secondary MCL (µg/L)	Laboratory reporting level (µg/L)
Barium	2,000	2
Chromium	100	.8
Iron	[300]	8
Lead	*	1
Lithium	**	3
Manganese	[50]	.4
Mercury	2	.018
Strontium	**	.4
Zinc	[5,000]	3

Table 8. Concentrations of selected trace elements in water from selected wells and springs, eastern Snake River Plain

[See figure 2 for location of sites. Samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory. Analytical results in micrograms per liter (µg/L). Symbols: <, concentration is less than the laboratory reporting level (used to indicate that the detection of the constituent is unclear); *, quality-assurance sample (MV-28 and -34 are replicates of MV-14 and -48, respectively); E, estimated result (a result may be estimated for a variety of laboratory-specific reasons; for instance, the result may lie outside of the calibrated range of the instrument; uncertainty is higher for estimated results (Childress and others, 1999, p. 8-10))]

Site identifier	Barium (µg/L)	Chromium (µg/L)	Iron (µg/L)	Lead (µg/L)	Lithium (µg/L)	Manganese (µg/L)	Mercury (µg/L)	Strontium (µg/L)	Zinc (µg/L)
MV-2A	58	0.7 E	14	<1	41	14	<0.018	313	97
MV-14	45	1.4	<8	<1	37	<.4	<.018	293	<3
MV-16	21	2.0	<8	<1	23	.2 E	<.018	194	1.7 E
MV-19	33	1.5	<8	<1	32	<.4	<.018	250	<3
MV-20	21	2.3	<8	.7 E	19	.3 E	<.018	192	<3
MV-28*	44	1.3	<8	<1	38	<.4	<.018	291	<3
MV-31	51	1.3	<8	<1	40	.2 E	<.018	314	<3
MV-33	14	2.3	<8	1.0	11	<.4	<.018	166	346
MV-34*	49	2.3	7.3 E	.7 E	1.8 E	.4	<.018	229	110
MV-39	59	.6 E	<8	<.1	8.3	<.4	<.018	315	<1
MV-43	127	<.8	<8	<1	45	.2 E	<.018	536	<3
MV-47	18	2.1	<8	<1	22	<.4	<.018	185	3.9
MV-48	49	2.5	5.7 E	<1	1.7 E	.4 E	<.018	229	112
MV-49	61	.8 E	<8	<1	3.0 E	19	<.018	190	392
MV-51	62	.9	12	<1	42	.6	<.018	337	49
MV-54	98	1.1	<8	<1	52	<.4	<.018	430	268

Table 9. Maximum contaminant levels and laboratory reporting levels for major cations, dissolved silica, and nutrients in drinking water

[The maximum contaminant levels (MCL's) were established pursuant to the recommendations of the U.S. Environmental Protection Agency (2003) for community water systems and are included for comparison with results from this study. Units are in milligrams per liter (mg/L). Symbol: **, MCL has not been established]

Constituent	Maximum contaminant level (mg/L)	Laboratory reporting level (mg/L)
Calcium	**	0.01
Magnesium	**	.01
Sodium	**	.1
Dissolved silica	**	.2
Ammonia (as nitrogen)	**	.041
Nitrite (as nitrogen)	1	.01
Nitrate (as nitrogen)	10	[1].06
Orthophosphate (as phosphorus)	**	.18

[1]Nitrite plus nitrate (as nitrogen)

Table 10. Concentrations of major cations, dissolved silica, and nutrients in water from selected wells and springs, eastern Snake River Plain

[See figure 2 for location of sites. Samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory. Analytical results in milligrams per liter (mg/L). Symbols: <, concentration is less than the laboratory reporting level (used to indicate that the detection of the constituent is unclear); *, quality-assurance sample (MV-28 and -34 are replicates of MV-14 and -48, respectively); E, estimated result (a result may be estimated for a variety of laboratory-specific reasons; for instance, the result may lie outside of the calibrated range of the instrument; uncertainty is higher for estimated results (Childress and others, 1999, p. 8-10))]

Site identifier	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Dissolved silica (mg/L)	Ammonia (as nitrogen) (mg/L)	Nitrite (as nitrogen) (mg/L)	Nitrite + Nitrate (as nitrogen) (mg/L)	Orthophosphate (as phosphorus) (mg/L)
MV-2A	50	20	33	36	<0.041	<0.008	1	<0.18
MV-14	53	22	31	34	<.041	<.008	2.1	.018
MV-16	35	17	19	33	<.041	<.008	1	<.18
MV-19	46	20	25	33	<.041	<.008	2.6	<.18
MV-20	36	18	21	34	<.041	<.008	1.4	<.18
MV-28*	53	22	30	33	<.041	<.008	2.1	.017 E
MV-31	57	22	33	34	<.041	<.008	1.8	<.18
MV-33	28	15	14	35	<.041	<.008	.6	<.18
MV-34*	41	15	8	24	<.041	<.008	.7	<.18
MV-39	67	27	42	39	<.041	<.008	2.4	.057
MV-43	103	38	47	44	<.041	<.008	20	<.18
MV-47	33	16	18	33	<.041	<.008	.7	<.18
MV-48	41	15	8	23	<.041	<.008	.7	<.18
MV-49	50	16	8.6	29	.02 E	<.008	1.7	.013 E
MV-51	62	25	43	34	<.041	<.008	2.5	<.18
MV-54	71	28	51	37	<.041	<.008	5.2	<.18

Table 11. Maximum contaminant levels and minimum reporting levels for selected purgeable organic compounds in drinking water

[Samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory. Abbreviations: MCL, maximum contaminant level; MRL, minimum reporting level. MCL's were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1994; 2000, p. 419) for community water systems and are included for comparison with results from this study. Units are in micrograms per liter (µg/L). Symbol: **, MCL has not been established. Abbreviation: tthm, total trihalomethanes (trihalomethane analyses in this report include bromodichloromethane, dibromochloromethane, tribromomethane, and trichloromethane); MCL for tthm is 100 µg/L (U.S. Environmental Agency, 2003)

Purgeable organic compounds	MCL (µg/L)	MRL (µg/L)
Acrylonitrile	**	2.5
Benzene	5	.1
Bromobenzene	**	.2
Bromochloromethane	**	.2
Bromodichloromethane	tthm	.1
Bromomethane	**	.3
n-Butylbenzene	**	.2
sec-Butylbenzene	**	.2
tert-Butylbenzene	**	.2
1,1,2-Trichlorotrifluoroethane (CFC-113)	**	.1
Chlorobenzene	100	.1
Chloroethane	**	.2
Chloromethane	**	.2
2-Chlorotoluene	**	.2
4-Chlorotoluene	**	.2
Dibromochloromethane	tthm	.2
1,2-Dibromo-3-chloropropane (DBCP)	0.2	1
Dibromomethane	**	.2
1,2-Dibromoethane	**	.2
1,2-Dichlorobenzene	600	.1
1,3-Dichlorobenzene	**	.1
1,4-Dichlorobenzene	75	.1
Dichlorodifluoromethane (CFC-12)	**	.2
1,1-Dichloroethane	**	.1
1,2-Dichloroethane	5	.2
1,1-Dichloroethene	7	.1
cis-1,2-Dichloroethene	70	.1
trans-1,2-Dichloroethene	100	.1
Dichloromethane	5	.2
1,2-Dichloropropane	5	.1
1,3-Dichloropropane	**	.2
2,2-Dichloropropane	**	.2
1,1-Dichloropropene	**	.2
cis-1,3-Dichloropropene	**	.2
trans-1,3-Dichloropropene	**	.2
Ethylbenzene	700	.1

Table 11. Maximum contaminant levels and minimum reporting levels for selected purgeable organic compounds in drinking water—Continued

[Samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory. Abbreviations: MCL, maximum contaminant level; MRL, minimum reporting level. MCL's were established pursuant to the recommendations of the U.S. Environmental Protection Agency (1994; 2000, p. 419) for community water systems and are included for comparison with results from this study. Units are in micrograms per liter (µg/L). Symbol: **, MCL has not been established. Abbreviation: tthm, total trihalomethanes (trihalomethane analyses in this report include bromodichloromethane, dibromochloromethane, tribromomethane, and trichloromethane); MCL for tthm is 100 µg/L (U.S. Environmental Agency, 2003)

Purgeable organic compounds	MCL (µg/L)	MRL (µg/L)
Hexachlorobutadiene	**	.2
Isopropylbenzene	**	.2
4-Isopropyltoluene	**	.2
Methyl tert-butylether	**	.2
Napthalene	**	.5
n-Propylbenzene	**	.2
Styrene	100	.1
1,1,1,2-Tetrachloroethane	**	.2
1,1,2,2-Tetrachloroethane	**	.2
Tetrachloroethene	5	.1
Tetrachloromethane (Carbon tetrachloride)	5	.2
Toluene	1,000	.1
Tribromomethane (Bromoform)	tthm	.2
1,2,3-Trichlorobenzene	**	.2
1,2,4,-Trichlorobenzene	70	.2
1,1,1-Trichloroethane	200	.1
1,1,2-Trichloroethane	5	.2
Trichloroethene	5	.1
Trichlorofluoromethane (CFC-11)	**	.2
Trichloromethane (Chloroform)	tthm	.1
1,2,3-Trichloropropane	**	.2
1,2,4-Trimethylbenzene	**	.2
1,3,5-Trimethylbenzene	**	.2
Vinyl chloride	2	.2
Xylenes, total ortho, meta, and para	10,000	.2

Table 12. Maximum contaminant levels, laboratory reporting levels, and long-term method detection levels for selected insecticides in drinking water

[Samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory. Abbreviations: MCL, maximum contaminant level; LRL, laboratory reporting level; LT-MDL, long-term method detection level. MCL's were established pursuant to the recommendations of the U.S. Environmental Protection Agency (2000, p. 420-421) for community water systems and are included for comparison with results from this study. Units are in micrograms per liter (µg/L). Symbol: **, MCL has not been established]

Insecticides	MCL (µg/L)	LRL (µg/L)	LT-MDL (µg/L)
Azinphos, methyl-	**	.05	.02
Carbaryl (Sevin)	**	.041	.021
Carbofuran	40	.020	.010
Chlorpyrifos (Dursban)	**	.005	.003
DDE, p,p'-	**	.003	.0013
Diazinon	**	.005	.003
Dieldrin	**	.005	.0024
Disulfoton (Disyston)	**	.021	.011
Ethoprophos	**	.005	.002
Fonofos	**	.003	.0013
HCH, alpha-	**	.005	.0023
Lindane (HCH, gamma-)	.2	.004	.002
Malathion	**	.027	.014
Parathion	**	.01	.005
Parathion, methyl-	**	.006	.003
Permethrin, cis-	**	.006	.003
Phorate	**	.011	.006
Propargite	**	.023	.011
Terbufos	**	.017	.009

Table 13. Maximum contaminant levels, laboratory reporting levels, and long-term method detection levels for selected herbicides in drinking water

[Samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory. Abbreviations: MCL, maximum contaminant level; LRL, laboratory reporting level; LT-MDL, long-term method detection level. MCL's were established pursuant to the recommendations of the U.S. Environmental Protection Agency (2000, p. 420-421) for community water systems and are included for comparison with results from this study. Units are in micrograms per liter (µg/L). Symbol: **, MCL has not been established]

Herbicides	MCL (µg/L)	LRL (µg/L)	LT-MDL (µg/L)
Acetochlor	**	0.006	0.003
Alachlor	2	.004	.002
Atrazine	3	.007	.004
Atrazine, deethyl- (CIAT)	**	.006	.003
Benfluralin	**	.01	.005
Butylate	**	.002	.001
Cyanazine	**	.018	.009
Dacthal (DCPA)	**	.003	.0015
2,6-Diethylaniline	**	.006	.003
EPTC (Eptam)	**	.002	.0010
Ethalfluralin	**	.009	.005
Linuron	**	.035	.018
Metolachlor	**	.013	.006
Metribuzin	**	.006	.003
Molinate	**	.002	.0008
Napropamide	**	.007	.003
Pebulate	**	.004	.0021
Pendimethalin	**	.022	.011
Prometon	**	.0105	.007
Pronamide (Propyzamide)	**	.004	.0021
Propachlor	**	.01	.005
Propanil	**	.011	.005
Simazine	4	.005	.002
Tebuthiuron	**	.016	.008
Terbacil	**	.034	.017
Thiobencarb	**	.005	.0024
Triallate	**	.002	.0012
Trifluralin	**	.009	.005

Table 14. Concentrations of selected herbicides in water from selected wells and springs, eastern Snake River Plain

[See figure 2 for location of sites. Samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory. Units are in micrograms per liter (µg/L). Symbols: <, concentration is less than the laboratory reporting level (used to indicate that the detection of the constituent is unclear); *, quality-assurance sample (MV-28 and -34 are replicates of MV-14 and -48, respectively); E, estimated result (a result may be estimated for a variety of laboratory-specific reasons; for instance, the result may lie outside of the calibrated range of the instrument; uncertainty is higher for estimated results (Childress and others, 1999, p. 8-10)). Concentrations of herbicides listed in table 13, but not in table 14, were less than the laboratory reporting level for all samples]

Site identifier	Atrazine (µg/L)	Deethyl atrazine (µg/L)	Metribuzin (µg/L)
MV-2A	<0.007	<0.006	<0.006
MV-14	.006 E	.005 E	.005 E
MV-16	.006 E	.005 E	<.006
MV-19	.01	.007 E	<.006
MV-20	.01	.006 E	<.006
MV-28*	.006 E	.006 E	.005 E
MV-31	<.007	<.006	<.006
MV-33	<.007	<.006	<.006
MV-34*	<.007	<.006	<.006
MV-39	.01	.010 E	<.006
MV-43	.01	.019 E	.04
MV-47	<.007	<.006	<.006
MV-48	<.007	<.006	<.006
MV-49	<.007	<.006	<.006
MV-51	<.007	.004 E	<.006
MV-54	.01	.008 E	<.006